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Code 2 B

X63-11394

NASA TT F-8339

NEW INDICATIONS ON THE EXISTENCE OF EXTENSIVE ATMOSPHERE SHOWERS ATTRIBUTABLE TO THE PRIMARY PHOTONS

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON DECEMBER 1962

DRAFT TRANSLATION NASA TT F-8339

NEW INDICATIONS ON THE EXISTENCE OF EXTENSIVE ATMOSPHERE SHOWERS ATTRIBUTABLE TO THE PRIMARY PHOTONS *

C. R. Academ.des Sciences
T. 255, No. 19, 2411 – 2413
Paris, 5 November 1962.

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ABSTRACT.

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Extensive showers, abnormally poor in penetrating particles, have been revealed. They are attributable to primary photons. Their frequency constitutes one percent of the ordinary showers of the same dimensions.

* * *

In a preceding article [1] we mentioned the possibility of existence of high-energy photons (10^{15} – 10^{16} eV) in the extra-atmospheric space, and we described a project of a method for their detection by the registration of extensive showers abnormally poor in hard component.

In a subsequent publication [2] we presented the preliminary results demonstrating the possible existence of such showers. We now present in a condensed form the results of longer series of observations, utilizing a broader system : 18 months of registration with an effective surface under lead $S_p = 7.6$ m^2, composed of M = 56 elements branched to a hodoscope, and 10 months with a surface $S_p = 14.1$ m^2 composed of

* Indications nouvelles sur l'existence de grandes gerbes de l'air attribuables à des photons primaires. (Note presented by M. Francis Perrin).

104 hodoscoped elements. The electron density is determined by 8 benches composed of 72 bare hodoscoped counters of 0.125 m^2 surface each.

Each registration indicates the number **m** among the M detectors operated under the lead, and simultaneously the electron density determined by the number **k** among the K bare counters affected.

The aggregate of registrations is divided into eight constant intervals of log ($\Delta_e S_p$), the value $\Delta_e S_p$ representing the mean number of electrons falling on the lead surface. The meaning of $\Delta_e S_p$ is independent from the change in the surface S_p, if Δ_e is changed accordingly. The width of the intervals of log ($\Delta_e S_p$) is equal to 0.01, the value of $\Delta_e S_p$ varying from 220 to 1380.

The ratio of the extreme values is about 7; however, the total number of particles in an observed shower varies from 10^5 to $2.5 \cdot 10^6$, since besides the value $\Delta_e S_p$ the distance from the axis of a shower to the center of the apparatus also varies around the most probable distance.

The frequency of registrations of penetrating events may be computed by the relation

$$N_{m,k} = A \binom{M}{m} \int_0^\infty (1 - e^{-x})^m e^{-(M-m)x} f(x,k)\, dx$$

with $x = \Delta_p S_p / M$, where Δ_p is the density of the penetrating component, $f(x, k)$ being a function representing the spectrum of the penetrating component imposed by the device detecting the electronic component. We treated the function $f(x,k)$ in a most purely formal fashion by trying various analytical expressions until the values of $N_{m,k}$ so computed approach the experimental values of $N_{m,k}$ at best.

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Before proceeding with the selection of $f(x,k)$, it is necessary to take into account the fact that the spatial distribution of particles under the absorbent is not Poissonian on account of the secondary events produced inside. This is translated by a deviation in the repartition of the affected detectors relative to a hypergeometrical distribution.

This question is the object of a closer elaboration in the work [3]. On the basis of a detailed analysis of the "groupings" of the affected detectors, one may re-establish a repartition as it would have been, if there were no secondary multiplications in the lead. This correction is rather important, for it raises the frequency of the weak multiplicities m, except of course $m = 0$.

In trying a great number of propositions, we have finally selected a function $f(x,k)$ written by utilizing a variable $z = (x - x_0)/x_0$:

$$f(z) = B e^{-\alpha z} z^{\beta},$$

with $\alpha = 0.001$ and $\beta = 3$. The value of x_0 is linked in a fixed fashion to x_f (the histogram's maximum) for a given value k.

Since $Z_f = (x_f/x_0) - 1 = \beta/\alpha$, we have

$$\frac{x_0}{x_f} = \frac{\alpha}{\beta} = \frac{1}{3\,000} .$$

The introduction of so small a x_0 appropriate to every Δ_e (through x_0/x_f) has no real meaning except for the possibility of writing the function $f(x,k)$ in a general form $f(z)$ applicable to all the different cases of various Δ_e and m.

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As a limited example, one represents the aggregate of the results in the form of sums of events (in all the intervals of $\Delta_e S_p$) for various **m**. The total sum of the integrals $N_3 + N_4 + N_5 + N_6 + N_7$ is normalized at the sum of the respective corrected experimental values :

m	0	1	2	3	4	5	6	7
Corrected experimental N_m	2686	5 573	7 811	9 212	10 023	9 739	8741	7 748
χ^2	165	58	12.4	9.5	9.1	10.1	8.1	6.3
P ($>\chi^2$)	—	—	0.09	0.22	0.25	0.19	0.31	0.5

We then represented the values χ^2 computed for seven intervals of $\Delta_e S_p$ and also the probabilities P ($>\chi^2$) for seven degrees of liberty each (the registration of every **m** is divided in eight intervals, of which the last two are reassembled). The test of χ^2 gives a complete disagreement for $m = 0$ and $m = 1$ while proving at the same time a remarkable agreement forall the **m's** between 3 and 7. (It was not deemed useful to prolong the computations above $m = 7$). We also note that the experimental results obtained for $\Delta_e S_p > 1070$ provide 19 "zeros" and 14 "unities" in complete disagreement with the calculated ratio, which is $N_o / N_1 = 1/4$. It is in that last part of $\Delta_e S_p$ that the effect searched for is most evident : it constitutes about 80% of the registered "zero" events.

We believe that our observations can be only explained by admitting the existence of a groupe of showers abnormally poor in penetrating particles.

The proportion of abnormal showers is estimated as follows: the complete statistical series includes 98 269 recordings in the

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eight intervals of $\Delta_e S_p$ and we find therein 950 abnormal recordings $m = 0$ and $m = 1$, which gives a global observed effect of about 1% of photonic showers (γ— showers) relative to ordinary nuclear showers (p — showers) containing the same total number of particles (size). The limits of error in this evaluation must not exceed 1/3rd of the value found.

As we remarked in reference [1], the γ - and p- showers of same size at the ground do not have the same energy : the ratio of abnormal to normal showers having the same energy must be much lower, for example 0.1 %.

The value of our effect is now greater than in our preceding indications. This stems from the fact that we now know that the abnormal showers are not entirely devoid of mesons, which explains the abnormal cases with $m = 1$ [4]. For that reason the spectrum function has been revised, and new corrections were also introduced in our histograms (fortuitious coincidences).

The existence of two distinct types of showers is in opposition to every primary proton reaction process, such as the probability of energy transfer to a single π_o or photon decrease in a continuous manner when the energy increases.

The clear discontinuity observed allows to either visualize a new reaction process, or an extra-atmospherical origin of photons giving birth to abnormal showers.

**** E N D ****

Translated by ANDRE L. BRICHANT
FOR THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

16 December 1962

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